Low wind speed wind turbine in DIY version

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Fig. 1.

Wind turbine close to a small atelier

Fig. 2.
Earlier test of a small PE type without generator, 1.6m diameter, from a 80mm tube .

- Resists even only with furling tail, without brake or generator
- Does not resist with PVC tubes
- A 30 years old PE tube resists now in 3 years in site

Fig. 3.
Top of foil with reference line for the angle .

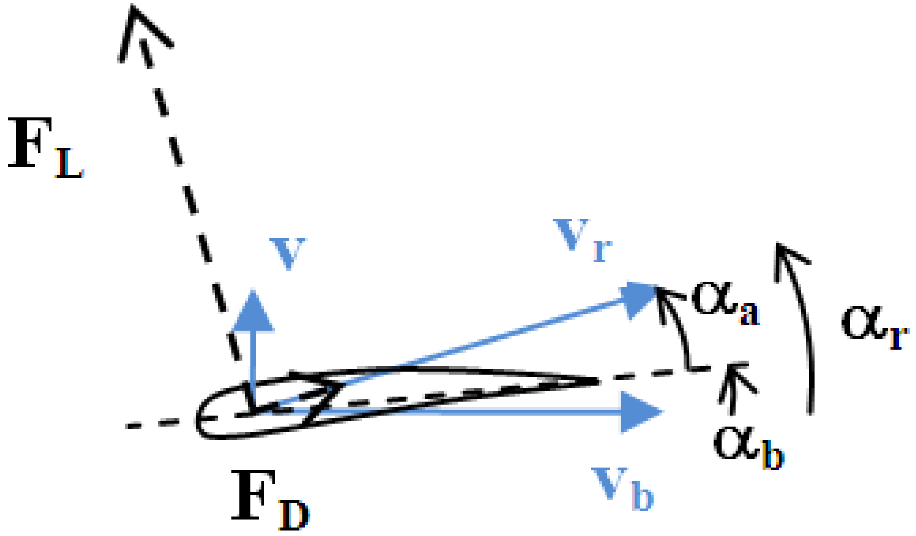

Fig. 4.
Different angles with lift and drag components .

TABLE I DATA OF THE AIR FOILS

type	NACA 9412	Cut PE tube
camber	9%	10%
Max height at	40%	36%
Max lift at	12°	
Zero lift	-9.5°	9°*
Stall angle	12°	
thickness	12%	12.6%
Max L/D	58.12	58.12/1.2*
Max L/D angle	0.5°	58.12/1.2*
Max C_L angle	14.5°	
Max C_L	2.148	2.1*
*: estimated		

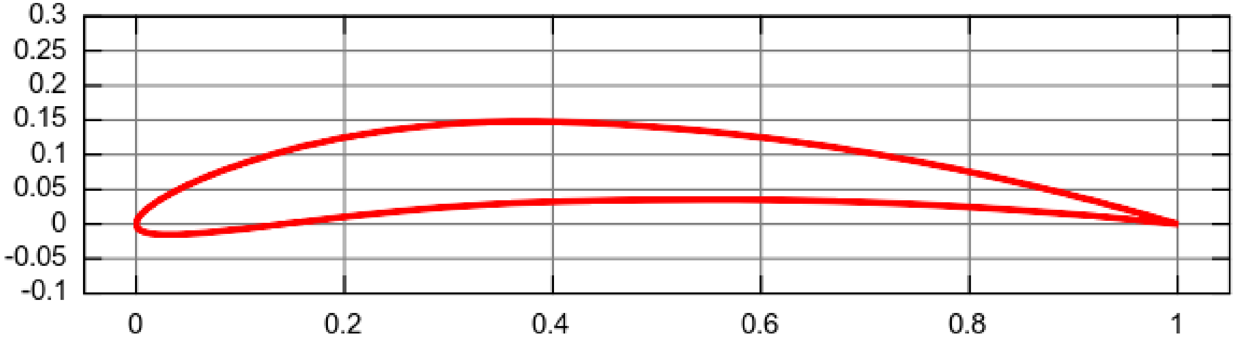

Fig 5. NACA9412 air foil

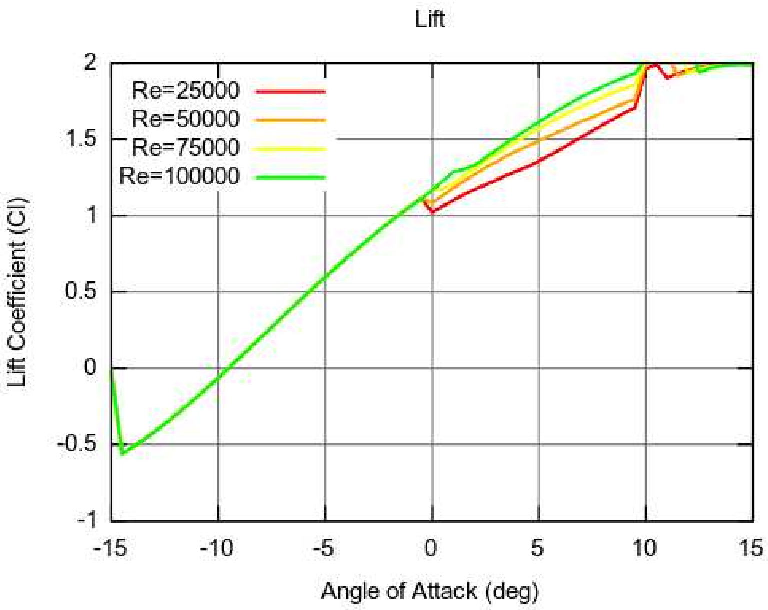

Fig 6.
CL depending on the angle of attack (NACA9412 air foil)

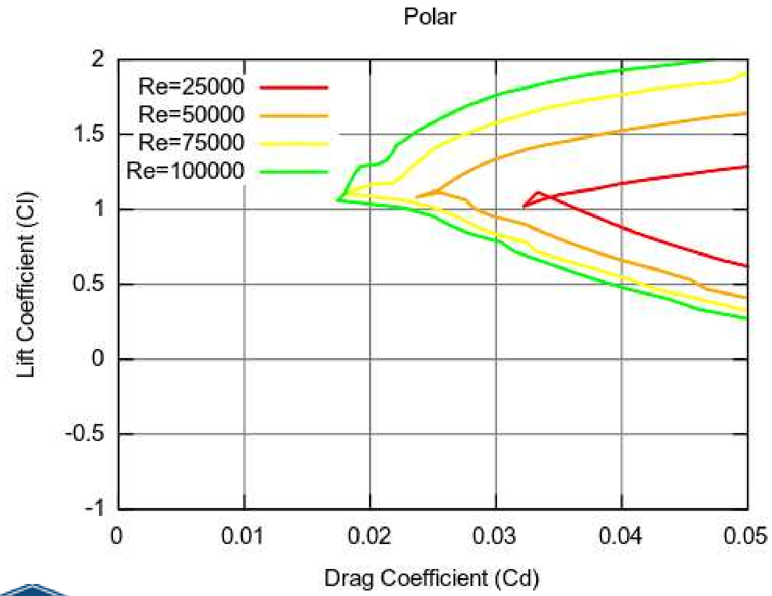

Fig 7.
CD depending on CL (NACA9412 air foil)

- Good maximum lift/drag
- Bad drag at low lift

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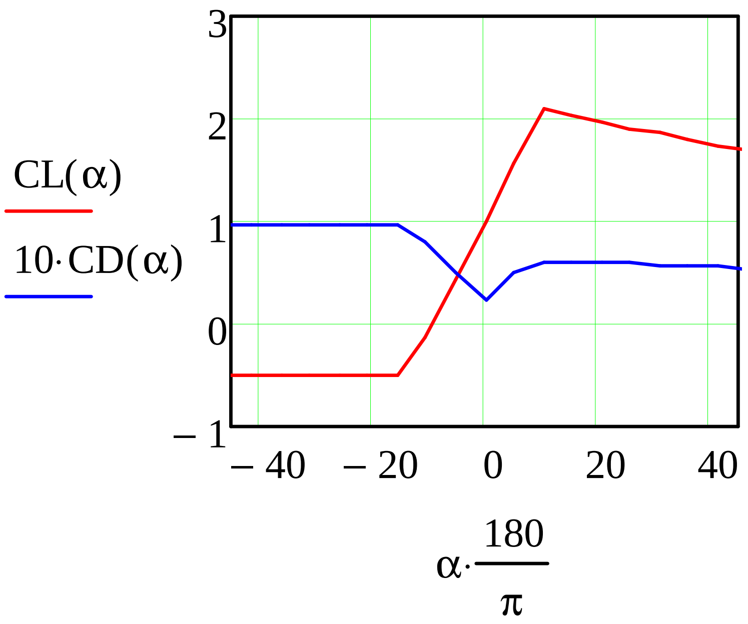

Fig. 8 Modeled lift and drag depending on the angle of attack

$$\frac{F_a}{\Delta r} = \frac{1}{2} \rho\, w b \left(v_r^2\right) \left(\sin(\alpha_r) C_L - \cos(\alpha_r) C_D\right)$$

(10) Force from air foil

v_r is tangential speed of the foil

$$F = \frac{1}{2} \rho\, S \left(v_1^2 - (2 v_1 - v)^2\right)$$

(6) Force from Betz theory

v= local at turbine

v1: undisturbed wind

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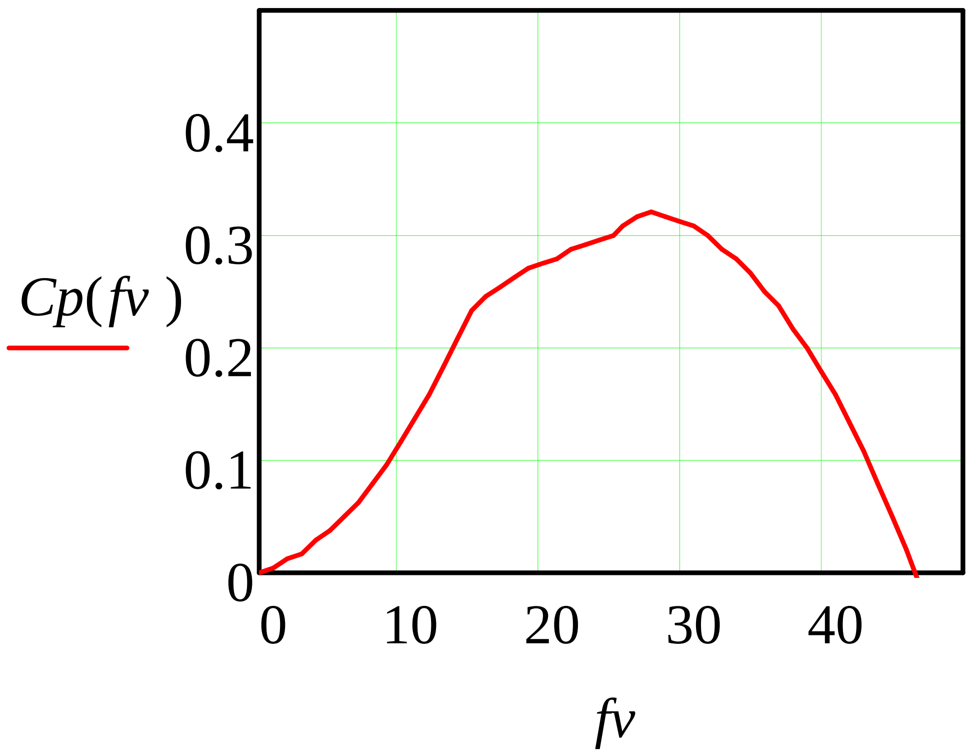

Fig. 9 Power coefficient versus frequency of the turbine at 7m/s wind speed

- Equalizing the both ways of force calculation permits to estimate the frequency – power coefficient curve

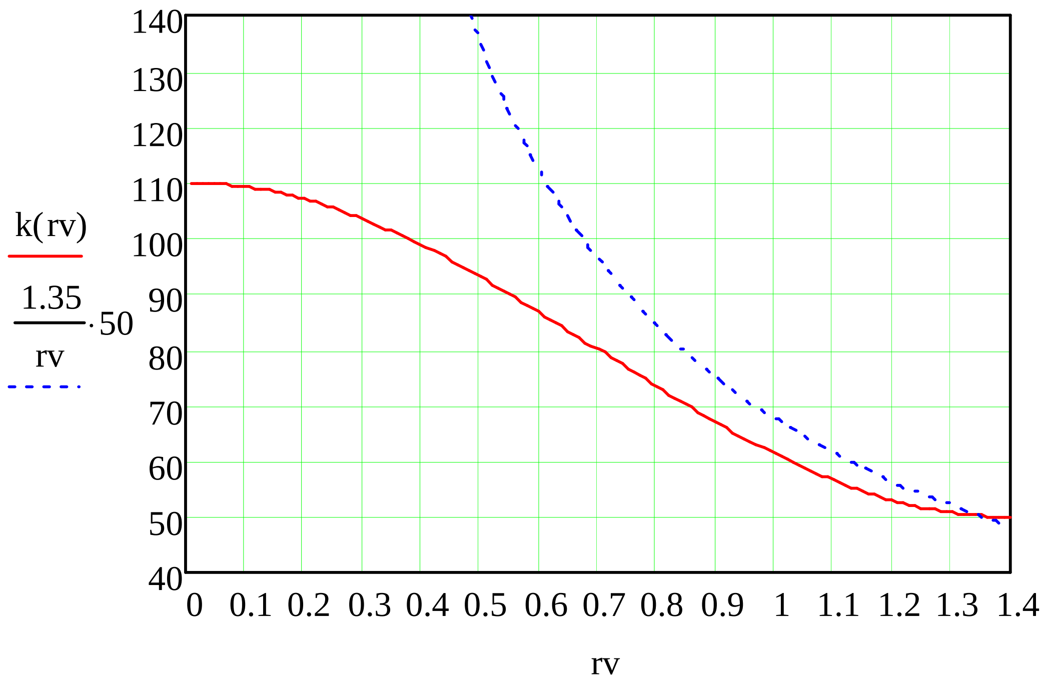

Fig. 9
Full line, the realized chord *k*(*rv*) [mm], depending on the distance from the axis.
A hyperbola is added in dotted line.

- Realised blade chord profile depending on radius

A compromise between strenght and ideal width

Fig 13.
A piece of PE tube for two blades, one curve is marked; upper left: planning machine.

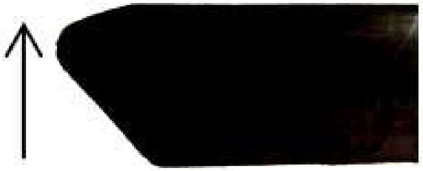

Fig 14.
Tip of the blade finishing and the direction of movement

Fig 15.
Erecting the turbine, showing the effect of the own weight of the nacelle.

Windlass inside the building, pulls up.
The link is to the roof, not to the wall

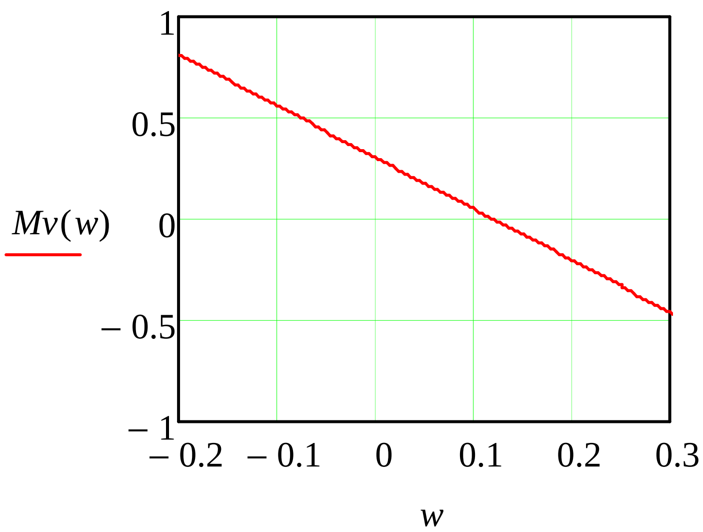

Fig 13.
Parasitic moment around the vertical axis, vertical [Nm] horizontal relative tilt [].

Fig 12. Bottom view of the nacelle, axis, bearing(black), skewed tail.

Tail skew

"Hybrid" vertical thrust bearing using marbles (black)

Tilt spacer

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Tail skew

“Hybrid” vertical thrust bearing using marbles (black)

Tilt spacer

Electric bike motor as Generator
and additional bearing

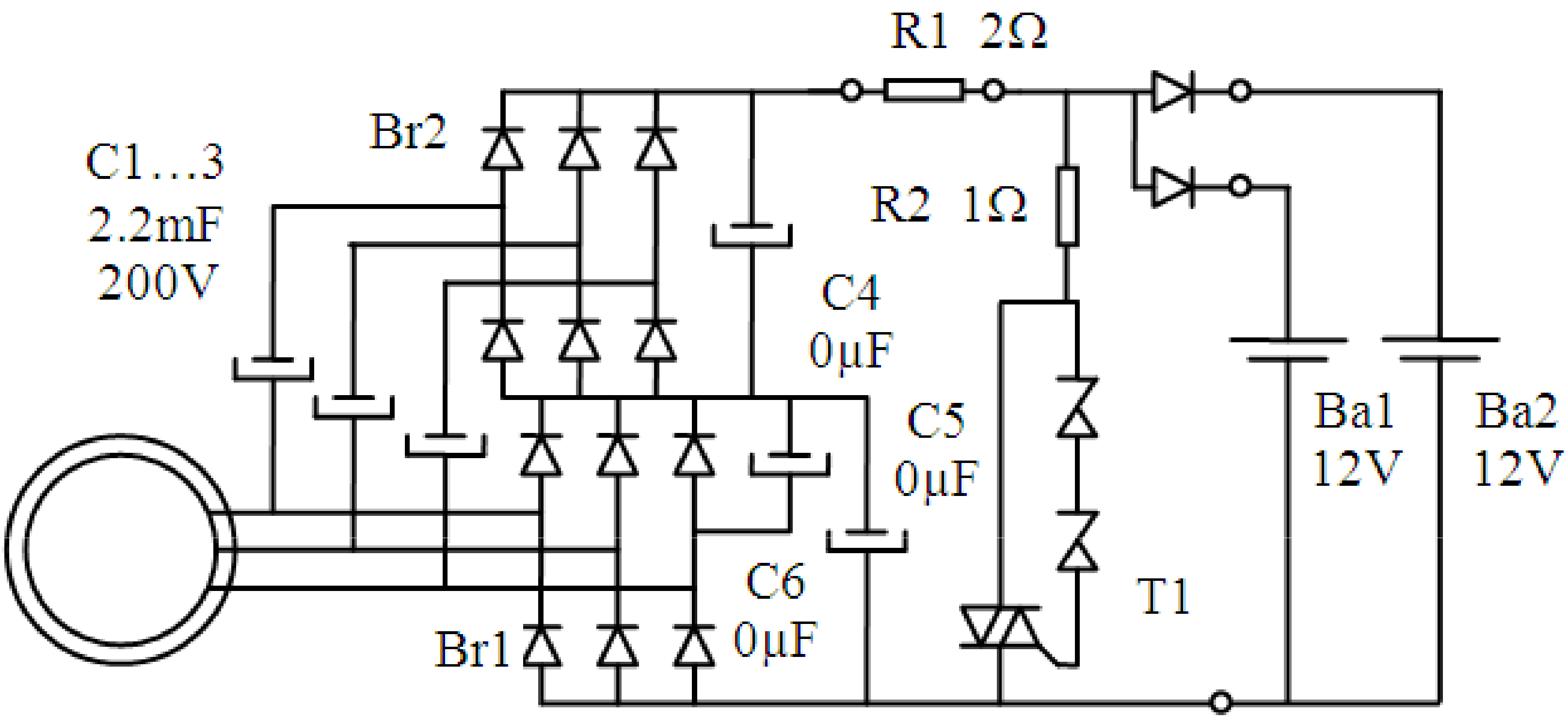


Fig. 17 Passive converter with three-phase voltage doubler
(or quadrupler if C4-C5-C6 are non-zero)

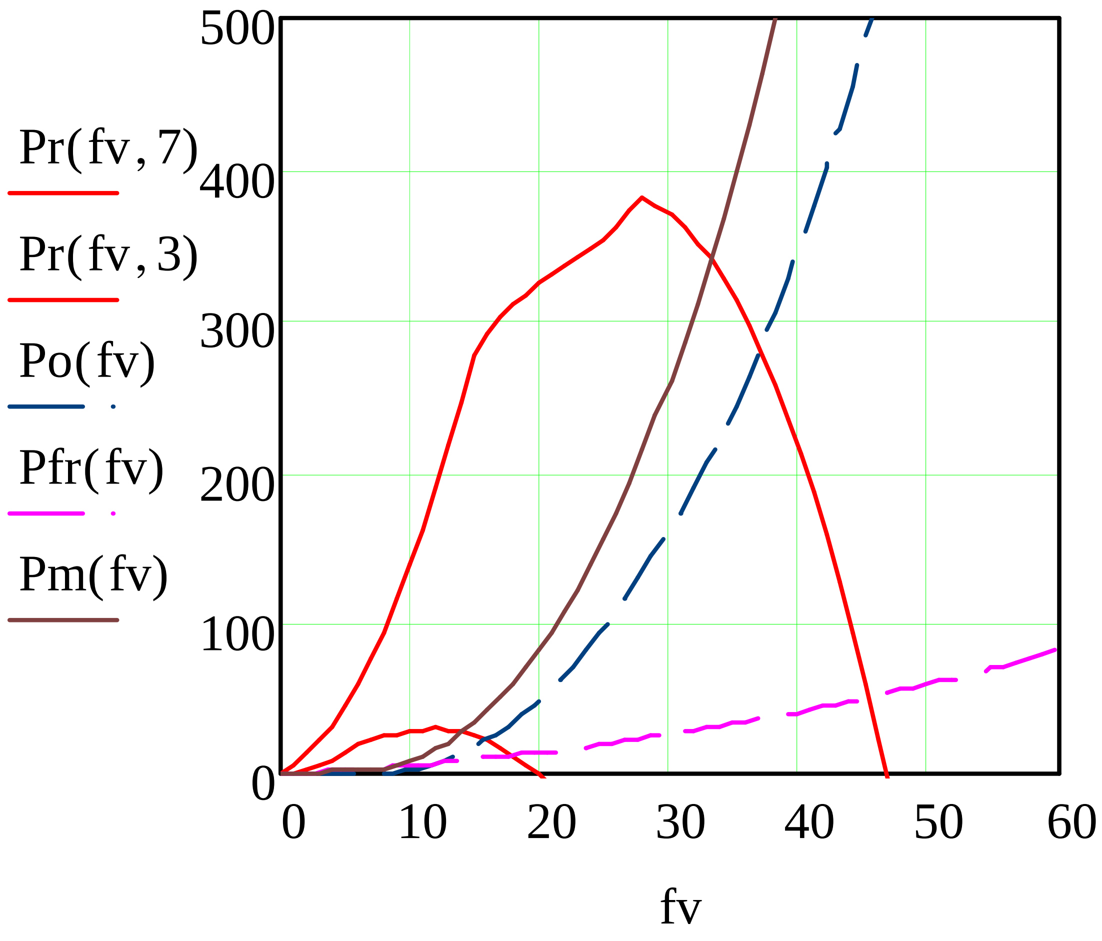
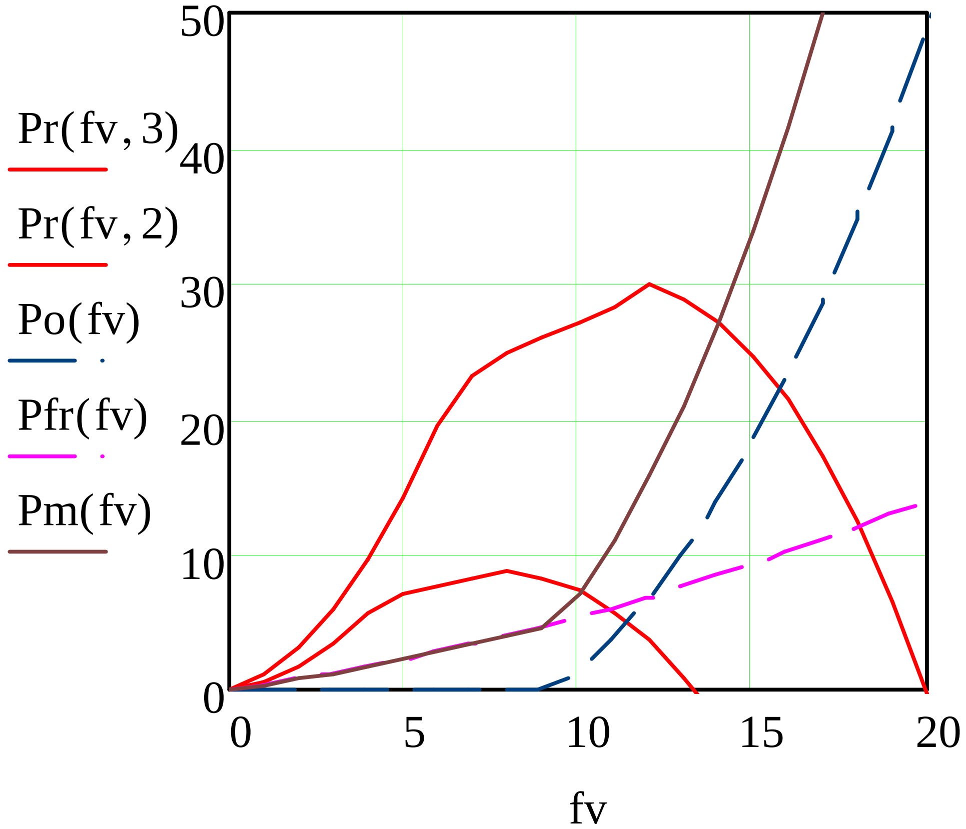


Fig. 19. Load and absorbed power and turbine characteristic for v1=3m/s and 2m/s

Close-up at low wind speed, taking friction into account



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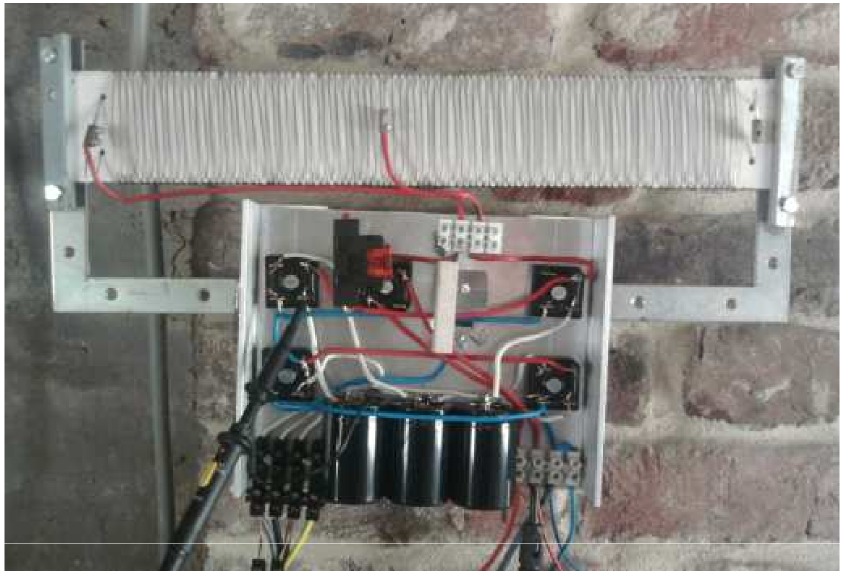

Fig. 20 Resistor Load and Rectifier and resistor closed and open.

A 1kWh battery charges in 8 days in winter.

Low Wind speed Wind Turbine in DIY

Conclusion:

- ✓ A low BOM (350 euro) is possible using
  - a bike PM generator
  - PE blades
  - Simplified tower
- ✓ One needs a voltage multiplier to use well a bike generator on 12V battery at low wind speed.
- ✓ PE blades resist well to harsh conditions
- ✓ Inland small wind turbines are still not very cheap compared to solar
- ✓ Wind turbines generate more electricity in winter.